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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Preparing Activity: KSC

NASA/KSC-26 05 13.00 98 (October 2007)

Superseding
NASA/KSC-26 05 13.00 98 (April 2006)

NASA/KSC GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2009

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DIVISION 26 - ELECTRICAL

SECTION 26 05 13.00 98

MEDIUM VOLTAGE CABLE

10/07

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SECTION 26 05 13.00 98

MEDIUM VOLTAGE CABLE
10/07

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NOTE: This specification covers the requirements for medium voltage cables, including 5 kV and 15 kV shielded single-conductor power cables, cable splices and terminations, potheads, and fireproofing cables in manholes.

Drawings must show plan layout of power cable and power-cable terminations. Electrical riser diagrams must show size, type, electrical characteristics, and raceway system of power cables and type of cable termination.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.
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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text are automatically deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C119.1	(1986) Electric Connectors - Sealed Underground Connector Systems Rated 600

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS8	(2000) Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ASTM INTERNATIONAL (ASTM)

ASTM B 8	(2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 746	(2007) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 386	(2006) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE Std 48	(1996; R 2003) Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ACCEPT	(2003) The NETA Acceptance Testing Specifications
NETA MAINT	(2005) Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WC 8	(1988; Rev 3 1996) Ethylene-Propylene-Rubber-Insulated Wire

and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2007; AMD 1 2008) National Electrical Code - 2008 Edition

1.2 DEFINITIONS

Medium voltage power cables means all cables rated above 601 to 35,000 volts.

1.3 GENERAL REQUIREMENTS

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NOTE: If Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL and Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS are not included in the project specification, insert applicable requirements therefrom and delete the following paragraph.
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Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL and Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS apply to work specified in this section.

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Keep submittals to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, use a code of up to three characters within the submittal tags following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that reviews the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Provide manufacturer's catalog data for the following items:

Single Conductor 5 kV Shielded Cable
Single Conductor 15 kV Shielded Cable
Cable Supports and Fittings
Cable Tags
Fireproof Tape
Splice Kits (including splice grounding)
Terminations

SD-06 Test Reports

Submit test Reports in accordance with the paragraph entitled, "Field Testing," of this section.

Insulation Resistance Test
Direct-current high-potential test

SD-07 Certificates

Provide Listing of Products Installed showing qualifications of cable splicers to the Contracting Officer prior to specified work.

Prepare and submit a Pulling Plan including calculations of pulling tension and sidewall pressure anticipated, and the maximum allowable pulling tension for each pull.

Provide certificates for the following showing that the cable manufacturer has made factory-conducted tests on each shipping length of cable. Certified copies of test data must show conformance with the referenced standards and must be approved prior to delivery of cable.

Conductor Resistance
Accelerated Water Absorption Test
Water Immersion Test
Ionization
High-Voltage
Mechanical Integrity
Bending Test
High-Voltage Time Test
Dielectric Power Loss
Power-Factor Tests
Qualifications of Cable Splicers
Dielectric Termination Tests

Partial Discharge Test

SD-08 Manufacturer's Instructions

Provide manufacturer's instructions showing the recommended sequence and method of installation for the following:

Single Conductor 5 kV Shielded Cable
Single Conductor 15 kV Shielded Cable
Terminations
Splice Kits (including splice grounding)

1.5 QUALIFICATIONS

Provide Qualifications of cable splicers.

Personnel performing splicing must have [5] [_____] years experience in cable splicing and terminations of the type used in this project. Once a termination or splice has been started by a worker, the same person must complete that particular splice. Start and complete each termination and splice in one continuous work period.

1.6 CABLE VOLTAGE RATINGS AND USE

Medium-voltage power cables must include multiple- and single-conductor cables rated as follows, phase-to-phase, for grounded neutral systems:

Use cables rated [5,000] [15,000] volts, grounded neutral, on [2,400/4,160] [13,200] [13,800]-volt, three-phase, 60-hertz distribution systems.

Install cables in a duct and manhole system which can be subject to continuous immersion in a coastal environment containing brackish water at depths of up to 4.5 meters 15 feet.

1.7 FACTORY TESTING

Submit certified evidence that the cable manufacturer has made factory-conducted tests on each shipping length (reel) of cable; submit certified copies of test data in accordance with applicable provisions of the referenced standard. Tests on each length of cable must include conductor resistance; ionization; high voltage; partial discharge test. Contracting Officer or designee must have the option of witnessing required factory testing at no additional cost. Provide a schedule of manufacturing and testing in advance to permit such witnessing, if desired.

Submit certified evidence that the cable manufacturer has made factory-conducted sample tests in accordance with the applicable referenced standards. Tests on each sample of cable must include mechanical integrity, bending test, high-voltage time test, dielectric power loss, dielectric termination tests and power-factor tests. Certified copies of test data must show conformance to the requirements of referenced standards and must be submitted for approval prior to shipment of the cable.

Prior to manufacturing, data regarding degradation of proposed insulating material and cable performance due to water immersion test as specified in this specification must be provided to Contracting Officer or designee. Information must indicate A.C. breakdown stress in kV/mm or V/mil versus immersion time. A complete cable description and condition under which cable was tested must accompany the test information. Also submit

Accelerated water absorption test.

1.8 SHIPMENT

Submit Listing of products installed.

The shipment of cable must be made on reels in such a manner that the cable is protected from mechanical injury. Each end of each length of cable must be hermetically sealed using heat-shrinkable molded cable end caps to exclude moisture and securely attached to the reel.

The minimum diameter of the reel drum must be 14 times the overall diameter of the cable. Those reels less than 1524 millimeter 60 inches in diameter must have arbor holes sized for 65 millimeter 2-1/2 inches spindles; those greater than 1524 millimeter 60 inches in diameter must have arbor holes sized for 76 millimeter 3 inch spindles. Reel sizes must accommodate reel lengths specified in purchase order. Each reel must contain only one length of cable cut to order.

Each reel must have an arrow and appropriate wording stenciled in plain view on each side to indicate proper rotation of reels. Each reel must be plainly marked on each side, and on a tag attached to the cable end inside the lagging, with the following information:

a. Purchaser's order number:

b. Complete description of cable including manufacturer, cable size, voltage rating, percent insulation rating, insulating material, conductor size(s), year of manufacture;

c. Actual shipping cable (reel) length;

d. Reel number (e.g. 2 of 10);

e. Gross weight (i.e. with reel) and net weight (i.e. cable only).

Reels must be shipped in a vertical position, sufficiently blocked in the bed of shipping vehicle to preclude movement.

PART 2 PRODUCTS

2.1 CONDUCTORS

2.1.1 Material

Core (phase) conductor material must be annealed copper in accordance with ASTM B 8 with a filled strand construction. Conductor must be filled with semiconducting material to prevent moisture migration. Filler material must have proven long term chemical compatibility with both the conductor and overlying insulation screen materials.

2.1.2 Stranding

Conductors must be Class B stranded.

2.2 CABLE IDENTIFICATION

Cables must have printing on the outer jacket showing the cable type, name of the manufacturer, the year in which the cable was manufactured,

sequential cable reel length markings and a unique number for identification purposes. Information must be closely grouped on the tape at 1.8 meters 6 foot maximum intervals to permit complete identification.

2.3 15 KV CABLES

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NOTE: Due to the high available fault currents on Kennedy Space Center's 5 kV and 15 kV systems, minimum conductor and concentric neutral sizes are required. for most areas of KSC, use at least No. 4/0 AWG with full neutral or 350 kcmil with 1/3-neutral. Areas far from supply substations can use smaller cable sizes. Conduit size must be 5-inch minimum.

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2.3.1 General; 15 kV Cable

Single conductor 15 kV shielded cable assemblies must consist of: Conductor core described above, an extruded semiconducting shield over the conductors, 5.59 millimeter 220 mils of ethylene-propylene-rubber (EPR) insulation, an extruded semiconducting insulation shield, a concentric neutral, and a polyethylene (PE) jacket. The cable must be rated for minimum 90 degrees C continuous conductor temperature and 130 degrees emergency overload.

Single-conductor, ethylene-propylene-insulated, polyethylene-jacketed, shielded cable must conform to NEMA WC 8 and AEIC CS8.

2.3.2 15 kV Cable Conductor Shielding

Conductors must have a stress control layer consisting of extruded material applied between the conductor and the insulation to form a conductor shield (strand screen). This material must have proven long-term chemical compatibility with both the conductor and overlying insulation materials. This stress control layer must meet the electrical and physical requirements of NEMA WC 8.

2.3.3 Insulation; 15 kV Cable

Insulation material must be an ozone resistant, extruded thermosetting ethylene-propylene based polymer. Insulation must be capable of withstanding the continuous and emergency overload temperature ratings of the conductor.

2.3.4 Non-metallic Insulation Shield; 15 kV Cable

Extruded insulation shield must be an extruded thermoset material compatible with the insulation and jacket. Insulation shield must be applied directly over and bonded to the insulation, and must comply with AEIC CS8.

2.3.5 Concentric Neutral Shield; 15 kV Cable

Copper wires helically applied over the insulation shield. Minimum total cross sectional area of the shield wires is 1/3 the core conductor and no less than 20 No. 14 AWG, 13 No. 12 AWG or 9 No. 10 AWG. Minimum size of an individual shield wire is No. 14 AWG. Where "full neutral" is specified,

minimum total cross sectional area of the shield wires is equal to the core conductor.

2.3.6 Jacket; 15 kV Cable

Polyethylene (PE) must be extruded over the concentric neutral to a minimum thickness of 2 millimeter 80 mils.

2.4 5 KV CABLES

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NOTE: Due to the high available fault currents on Kennedy Space Center's 5 kV and 15 kV systems, minimum conductor and concentric neutral sizes are required. for most areas of KSC, use at least No. 4/0 AWG with full neutral or 350 kcmil with 1/3-neutral. Areas far from supply substations can use smaller cable sizes. Conduit size must be 5-inch minimum.
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2.4.1 General; 5 kV Cables

Single conductor 5 kV shielded cable assemblies must consist of: Conductor core described above, an extruded semiconducting shield over the conductors, 2.92 millimeter 115 mils of ethylene-propylene-rubber (EPR) insulation, an extruded semiconducting insulation shield, a concentric neutral, and a polyethylene (PE) jacket. The cable must be rated for minimum 90 degrees C continuous conductor temperature and 130 degrees emergency overload.

Single-conductor, ethylene-propylene-insulated, polyethylene-jacketed, shielded cable must conform to NEMA WC 8 and AEIC CS8.

2.4.2 5 kV Cable Conductor Shielding

Conductors must have a stress control layer consisting of extruded material applied between the conductor and the insulation to form a conductor shield (strand screen). This material must have proven long-term chemical compatibility with both the conductor and overlying insulation materials. This stress control layer must meet the electrical and physical requirements of NEMA WC 8.

2.4.3 Insulation; 5 kV Cable

Insulation material must be an ozone resistant, extruded thermosetting ethylene-propylene based polymer. Insulation must be capable of withstanding the continuous and emergency overload temperature ratings of the conductor.

2.4.4 Non-metallic Insulation Shield; 5 kV Cable

Extruded insulation shield must be an extruded thermoset material compatible with the insulation and jacket. Insulation shield must be applied directly over and bonded to the insulation, and must comply with AEIC CS8.

2.4.5 Concentric Neutral Shield; 5 kV Cable

Copper wires helically applied over the insulation shield. Minimum total

cross sectional area of the shield wires is 1/3 the core conductor and no less than 20 No. 14 AWG, 13 No. 12 AWG or 9 No. 10 AWG. Minimum size of an individual shield wire is No. 14 AWG. Where "full neutral" is specified, minimum total cross sectional area of the shield wires is equal to the core conductor.

2.4.6 Jacket; 5 kV Cable

Polyethylene (PE) must be extruded over the concentric neutral to a minimum thickness of 2 millimeter 80 mils.

2.5 INSULATED MEDIUM VOLTAGE CONNECTORS

IEEE Std 386. Connector must have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material Provide connectors as indicated.

a. 200 Ampere loadbreak connector ratings: Voltage: 15kV, 95kV BIL. Short time rating: 10,000 amperes rms, symmetrical for a time duration of 0.17 seconds.

b. 600 Ampere deadbreak connector ratings: Voltage: 15kV, 95kV BIL. Short time rating: 27,000 ampere rms, symmetrical for a time duration of 4.0 seconds.

Connections must be compatible with equipment bushings.

2.6 SPLICES

Splice kits must be the product of a single manufacturer, either heat shrink or cold shrink, meeting the requirements of the paragraph entitled "Splices and Terminations" under Part 3 of this specification.

2.7 TERMINATIONS

Terminations must be Class 1 per IEEE Std 48.

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NOTE: Coordinate the following paragraph with Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION if Section 33 71 02.00 20 is used in this project.
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2.8 CABLE SUPPORTS AND FITTINGS

[Cable supports, related fittings, and accessories for use in corrosive underground locations, such as manholes, must be provided with a factory applied coating of polyvinylchloride of at least [0.51] [_____] millimeter [20] [_____] mils thick. Polyvinylchloride (PVC) coated items must have a uniform thickness and be free of blisters, breaks, and holidays. PVC compound must conform to ASTM D 746.]

[Cable racks, rack arms, cable tray supports and related fittings must be UL listed [standard] [heavy]-duty nonmetallic [glass-reinforced nylon] [polycarbonate].]

2.9 CABLE TAGS IN MANHOLES AND AT TERMINATIONS

Provide tags for each cable or wire located in manholes and at each termination. Tag all cables indicated to have tags.

2.9.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 31 MPa 4500 pounds per square inch; and that are 0.9 millimeter 0.035-inch thick, non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 150 degrees C 300 degrees F. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties must have a minimum loop tensile strength of 780 newtons 175 pound. The cable tags must have block letters, numbers, and symbols 25 millimeter 1 inch high on a yellow background. Letters, numbers, and symbols must not fall off or change positions regardless of the cable tags orientation.

2.10 FIREPROOF TAPE

Fireproof tape must be approximately 0.8 millimeter 30 mils thick by 3 inches 76 millimeters 3 inches wide. The tape must consist of a flexible, unsupported elastomer that expands in fire to provide a thick char buildup between the flame and the cable. The tape must not give off a smoke when subjected to flames or support combustion. The tape must not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

PART 3 EXECUTION

3.1 INSTALLATION

Install medium-voltage cables in accordance with NFPA 70.

Verify existing phasing and phase rotation at each interface with existing cables or equipment. Provide qualified personnel and the appropriate medium and low voltage test equipment as required to safely perform this phasing. Match and maintain existing system phasing and phase rotation at each splice and termination.

Cable must be installed in underground duct banks; in conduit above and below grade; inside buildings; by open wire method; on insulator hooks; on racks; in wall and ceiling mounted cable trays; in manholes; and by direct burial.

Cable or conductors of a primary distribution system must be rejected when installed openly in cable trays or openly racked along interior walls; in the same raceway or conduit with ac/dc control circuits or ac power circuits operating at less than 600 volts; or in a manner allowing cable to support its own weight.

3.1.1 Protection During Splicing Operations

Blowers must be provided to force fresh air into manholes or confined areas where free movement or circulation of air is obstructed. Waterproof protective coverings must be available on the work site to provide protection against moisture while a splice is being made. Pumps must be used to keep manholes dry during splicing operations. Under no conditions must a splice or termination be made with the interior of a cable exposed to moisture. Moisture-test conductor insulation paper before the splice is

made. Use a manhole ring at least [150] [_____] millimeter [6] [_____]-inches above ground around the manhole entrance to keep surface water from entering the manhole. Plug unused ducts and stop water seepage through ducts in use before the splice is started.

3.1.2 Duct Cleaning

****
NOTE: Delete the heading and the following paragraph if the installation of power cables is in ducts and manholes provided under this project. Provisions for cleaning new duct are adequately covered in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.
****

Thoroughly clean ducts before installation of power cables. A standard flexible mandrel must be pulled through each duct to loosen particles of earth, sand, or foreign material in the line.

3.1.2.1 PVC Duct

Mandrel length must be not less than 12 inches long and must have a diameter 1/2 inch less than the inside diameter of the duct. A brush with stiff bristles must then be pulled through each duct to remove the loosened particles. Brush diameter must be the same or slightly larger than the diameter of the duct.

3.1.2.2 Existing Fiber (Orangeburg) Duct

Push rod through duct. Pull a series of four-2 inch wire brushes back and forth through the duct. Progressively increase the size of the four wire brushes until four-4 inch wire brushes can be pulled back and forth, and all of the debris has been removed. Next pull a flexible mandrel with two-4 inch heavy duty wire brushes on each side through the duct. The mandrel must not be less than 12 inches long, and must have a diameter that is inch to 1 inch less than the inside diameter of the duct. Next, pull a 5 foot section of sample cable, equivalent to what is being used. Finally, make the final cable pull on the same day the sample cable was pulled.

3.1.3 Pulling Cables in Ducts and Manholes

Submit a pulling plan.

Pull medium-voltage cables into ducts with equipment designed for this purpose, including power-driven winch, cable-feeding flexible tube guide, long radius quadrant block cable pulling sheaves, cable grips, and lubricants. Employ a sufficient number of trained personnel and equipment with two-way radio communication capability to ensure the careful and proper installation of the cable.

Set up cable reel at the side of the manhole or tunnel hatch opening and above the duct or hatch level, allowing the cable to enter through the opening without reverse bending. Install flexible tube guide through the opening in a manner that prevents the cable from rubbing on the edges of any structural member (manhole frame, chimney, duct, etc.).

Two long-radius (760 millimeter 30 inches minimum) quadrant block cable

pulling sheaves and necessary jamb skid support must be used at the pulling end to ensure that sidewall pressures during pulling are not excessive. Use a dynamometer in the pulling line to ensure that the pulling force is not exceeded. The pulling force must not exceed the smaller of: allowable tension on pulling device, allowable tension on cable, or the tension which produces the allowable sidewall pressure. The allowable tension on the pulling device is 28,900 newtons 6500 pounds for pulling eyes [and 4400 newtons 1000 pounds for pulling grip (where allowed)]. The allowable tension on cable must not exceed the value computed from the following equation:

TM = 0.036 0.008 X N X CM

Where: TM = maximum allowable pulling tension in newtons pounds

N = number of conductors in the cable

CM = cross-sectional area of each conductor in square millimeter circular mils

The allowable sidewall pressure is the smaller of 7300 newtons per meter 500 pounds per foot of bend radius or the cable manufacturer's recommended maximum value. The pulling plan submittal must show the calculations for allowable tension and sidewall pressure as well as the anticipated tension and sidewall pressure for each pull in the project.

Cable must be unreeled from the top of the reel. Payout must be carefully controlled. Cable to be pulled must be attached through a swivel to the main pulling wire by means of a [pulling eye installed by the factory or approved cable splicer] [suitable cable grip permitted only on cables less than 60 meter 200 feet long and less than 50 millimeter 2 inches in diameter].

Attach pulling eyes to the cable conductors of the 3-1/C circuit to prevent damage to the cable structure. The entire 3-1/C circuit must be pulled simultaneously.

Minimum bending radius during cable pulling operations must be 760 millimeter 30 inches. For permanent cable bending/racking the minimum bending radius must be 12 times cable diameter.

Liberally coat cables with a suitable cable-pulling lubricant as it enters the tube guide or duct. Grease and oil lubricants must not be used. Cover nonmetallic sheathed cables with wire-pulling compounds when required which have no deleterious effects on the cable. Rollers, sheaves, or tube guides around which the cable is pulled must conform to the 760 millimeter 30 inches minimum bending radius of the cable during the pulling operations.

Pull cables into ducts at a speed not to exceed [15] [_____] meters per minute [50] [_____] feet per minute and not in excess of maximum permissible pulling tension specified by the cable manufacturer. Cable pulling using a vehicle is not permitted. Pulling operations must be stopped immediately with any indication of binding or obstruction and must not be resumed until such difficulty is corrected. Provide sufficient slack for free movement of cable due to expansion or contraction.

Cable splices made up in manholes must be firmly supported on cable racks as indicated. No cable splices must be pulled in ducts. Overlap cable ends at the ends of a section to provide sufficient undamaged cable for

splicing. Cables to be spliced in manholes must overlap the centerline of the proposed joint by not less than [600] [_____] millimeter [2] [_____] feet.

Cables cut in the field must have the cut ends immediately sealed to prevent entrance of moisture with heat-shrinkable molded cable end caps.

3.1.4 Splices and Terminations

Make splices in manholes except where cable terminations are specifically indicated. Expedite splicing and terminating of cables to minimize exposure and cable deterioration.

Connect the cable concentric neutral/shield wires across each side of the splice and to one or two bare copper wires which are connected to the manhole grounding system. The total cross sectional area of the bare copper wires must be at least equal to the shield size. Make all connections within the splice utilizing barrel-type compression connectors and appropriate compression tools with proper size dies to ensure a satisfactory mechanical and electrical joint. Bare connections of concentric neutral/shield wires must be either contained within the splice kit or must be sealed via an additional outer covering. This outer covering must consist of a heavy wall, heat-shrinkable tubing containing adhesive material (mastic) that melts as heat is applied and the outer tubing shrinks to form a moisture proof environmental seal. The outer tubing must conform to ANSI C119.1. Take extra precautions to seal around the exit area of the bare copper jumpers with additional mastic, per the splice manufacturer's recommendations.

Terminate cables in approved cable terminations, rated Class 1 per IEEE Std 48. Dry terminations with medium voltage pennants, preformed, and hand wrapped stress cones can be used for terminating cables. Terminations must be provided with adequate means for making external connections to the cable conductors of single-conductor cables (phase and concentric neutral); protecting the cable insulation against moisture, oil, or other contaminant; physically protecting and supporting cables, and maintaining the insulation level of the cable.

Field fabricate terminations from termination kits supplied by and in accordance with the termination manufacturer's recommendations for the type, size, and electrical characteristics of the cable.

Installation must include built-up or prefabricated heat or cold shrink stress-relief cones at the terminals of all shielded cables and at the terminals of single-conductor lead-covered cables rated 15 kV and above.

Field fabricate cable splices from pre-molded or heat-shrinkable splicing kits supplied by and in accordance with the cable manufacturer's recommendations for the type, size, and electrical characteristics of the cable specified. Locate cable splices in manholes midway between cable racks on walls of manholes and support with cable arms at approximately the same elevation as the enclosing duct.

Install cable splices on cable racks or by other approved methods which minimize physical stress on the splice connections. Support splices at approximately the same elevation as the installed cable except where space limitations or existing cable length limitations make this method impractical or impossible.

Support all universal demountable splices in such manner so as to minimize physical stress on the splice connections. Support each cable end termination using a pair of saddle type supports under the cable end termination and/or cable with a minimum [300] [_____] millimeter and a maximum [750] [_____] millimeter [30] [_____] inches separation between the supports. Cable end termination and cable must be secured to the supports in such a manner as to prevent movement of termination or cable at the support. Install saddle type supports on galvanized steel framing channel anchored to the wall or securely fastened to the cable tray or installed by other approved methods.

3.1.5 Fireproofing

Provide fireproofing (Arc Proofing) for individual cable conductor in manholes, handholes and vaults which carry current at 2200 volts or more.

Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. Extend the tape 25 millimeter 1 inch into the ducts. To prevent unraveling, random wrap the fireproofing tape the entire length of the fireproofing with pressure-sensitive glass cloth tape.

3.1.6 Cable Tag Installation

Install cable tags in each manhole and at each termination as specified. Install cable tags over the fireproofing and position the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes and equipment.

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NOTE: Although NETA ACCEPT, NETA MAINT and referenced standards indicate higher DC High Potential test voltages, KSC has elected to use the values shown below.

****

3.2 FIELD TESTING

After the installation of power cables has been completed, including splices, joints, and terminations, and before the cable is energized, subject each medium voltage cable to field testing in accordance with NETA ACCEPT, NETA MAINT and the following requirements.

Provide test equipment, labor, and trained technical personnel as necessary to perform the electrical acceptance tests.

Obtain KSC Cable Test Report forms from the Contracting Officer prior to commencing Field Testing. Record all tests on forms provided.

Make arrangements to have tests witnessed and approved by the Contracting Officer.

Completely isolate each power-cable installation from extraneous electrical connections at cable terminations and joints. Observe safety precautions.

Each power cable must first be given an insulation resistance test using a megohmmeter with a voltage output of at least 2,500-volts. Apply test for a long enough time to fully charge the cable (no less than one minute). Record readings as indicated on forms provided. Minimum reading must be 5000 megohms at an ambient temperature of 20 degrees C 68 degrees F.

Readings taken at other than 20 degrees C 68 degrees F ambient temperatures must be corrected accordingly.

Upon successful completion of the insulation resistance test, subject the cable to a direct-current high-potential test. Maximum DC test voltage for new 15 kV cable must be 40 kilovolts, and for new 5 kV cable must be 15 kilovolts. Where new and existing cables are spliced together, maximum DC test voltage for 15 kV cable must be 12 kilovolts and for 5 kv cable must be 3600 volts.

Record leakage current readings and voltage decay readings as indicated in NETA ACCEPT, NETA MAINT and the KSC supplied test report form.
Final acceptance depends upon the satisfactory performance of the cable under test. No cable must be energized until recorded test data have been approved by the Contracting Officer.

Terminations must be clean and dry and must be tested per IEEE Std 48.
Perform radiographic tests on all terminations at the discretion of the Contracting Officer to determine if voids exist in the termination. Rework unacceptable cable, splices or terminations at no additional expense to the Government.

-- End of Section --